Studies on Replacement for the Cervical and Upper Thoracic Esophageal Defects by Free Transplantation of a Gastric or Intestinal Segment

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by

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INTRODUCTION

The reconstructive operation of the cervical and upper thoracic esophagus as surgical treatments for malignant tumors or cicatricial stenoses has become much easier by the use of free[29)34)35)37)] or pedunculated[4)20)33)41)] transplants of a gastric or intestinal segment. However, many problems concerning these operations, especially free transplantation, have remained unsolved.

With the progress of vascular anastomosing techniques, especially blood vessel suturing apparatuses, free transplantation of the gastrointestinal segment has produced good results and has been more frequently applied in clinical cases. But several difficulties are yet encountered by the use of these vascular anastomosing methods in patients with advanced arteriosclerotic changes. On the other hand, on the treatments after removing a free graft of gastric or intestinal segment, especially on the necessity of perfusion to wash the residual blood out of the graft opinions are divergent. Although blood vessels are reconstructed in free transplantation, nerves and lymphatic vessels remain divided. The influences of these incomplete reconstructions upon the structure and function of grafts, and choice of a suitable free graft among various parts of the alimentary tract should be investigated.

I PREPARATION OF A FREE GASTRIC OR INTESTINAL GRAFT IMMEDIATELY AFTER ITS REMOVAL

In free transplantation of a gastric or intestinal segment, it has not been decided whether the perfusion of the graft is to be carried out immediately after its removal or not. Of course, this problem is considered in the case of autotransplantation, and in homo- or heterotransplantation, perfusion should be performed because heterogenous proteins must be eliminated as much as possible.

1. Materials

Adult mongrel dogs ranging in weight from 10 to 25 kg were used. These dogs were anesthetized with intravenous administration of Nembutal (25 mg per kg).

2. Operative procedures

Transplants were mainly created from the greater curvature of the stomach, because

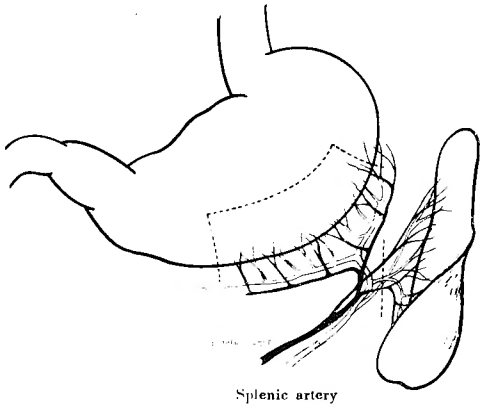

Fig. 1 Operative procedure to create the gastric tube.

of the larger diameter of blood vessels used for revascularization.

Gastric tubes, 2 cm in diameter and 8 cm in length, were constructed from a portion of the greater curvature which were supplied through gastroepiploic and short gastric vessels. Great omentum and spleen were resected but vascular arcades were preserved carefully, and the distal end of the gastric tube was closed (Fig. 1).

These gastric tubes were divided into two groups. In the pedunculated transplant group, the lymphatic vessels and exogenous autonomic nerves were preserved, but in the free transplant group, they were completely severed and blood supply was temporarily interrupted.

In similar fashion, intestinal tubes, about 15 cm in length, were created from a segment 30 cm oral from ileum end. They were supplied with blood through a single intestinal artery and vein, and were also divided into two groups.

3. Perfusates and the method of perfusion

Six percent low molecular weight dextran or physiologic saline solution, to which heparin (30 mg/200 ml) was added, was used.

A polyethylene tube (No. 5) was cannulated from a branch of the splenic artery up to its bifurcating point. Perfusion was carried out through the catheter under 120 to 150 mmHg pressure after the occlusion of the splenic artery.

4. Measurement of the oxygen tension in the venous blood flowing out of grafts and the blood flow supplying grafts

A polyethylene catheter (No. 6) was inserted into the abdominal aorta from the femoral artery and connected with a mercury manometer which recorded continuously the blood pressure of dogs. A three-way cock was interposed between the catheter and the manometer, and used for the purpose of sampling arterial blood. Oxygen tension was measured with a physiological gas analyzer (TOSHIBA-BECKMAN Co. Ltd.). A microelectrode was threaded through a branch of the splenic vein up to its junction with the splenic vein and the oxygen tension of the venous blood flowing out of the graft was recorded continuously (Fig. 2).

The author planned to determine the amount of blood flow supplying grafts by means of an electromagnetic flowmeter, but could not measure accurately on account of respiratory movement and a little quantity of the blood flow ranging in amount from 10 to 20 ml/min.. Therefore, it was determined directly by cannulating a catheter into a branch of the splenic vein and collecting whole blood flowing out of grafts[40].

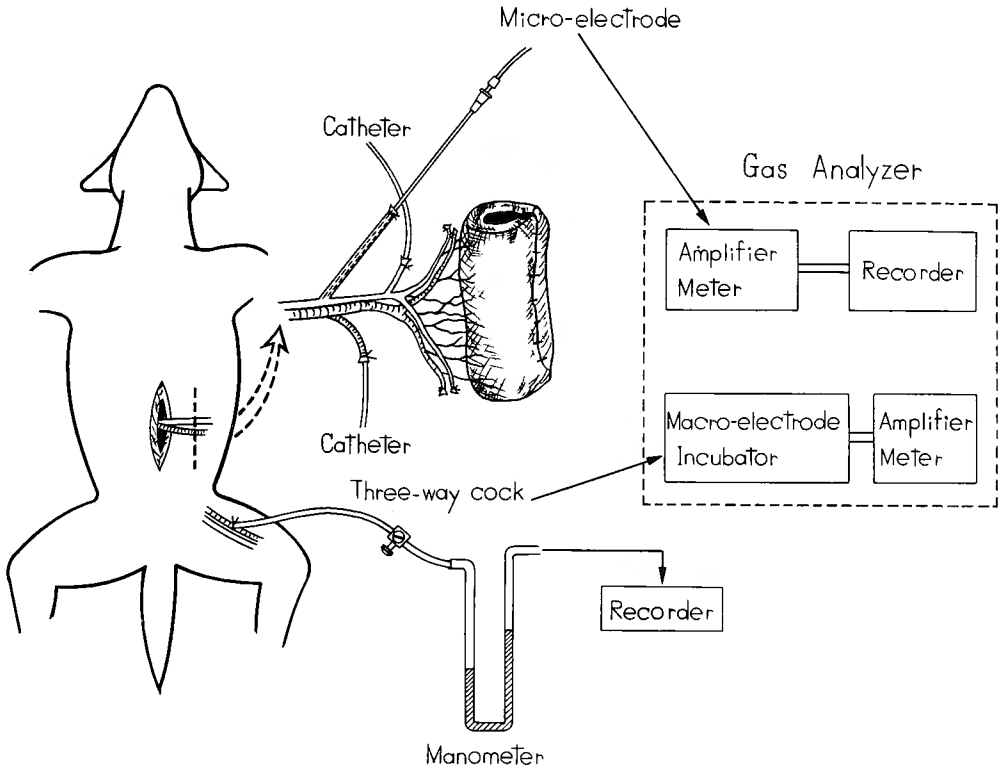

Fig. 2 Diagrammatic representation showing the method to measure oxygen tension of the venous blood flowing out of a graft. Blood pressure was also recorded continuously.

RESULTS

1. Non-perfusion group

The oxygen saturation of the venous blood flowing out of grafts became stable 30 minutes after the creation of the gastric tube. Then, the splenic artery was occluded and grafts were left at room temperature for an hour. Histamine solution (0.06 mg/kg of body weight) was injected intramuscularly 10 minutes after the release of occlusion of the artery. There were some individual differences in the effect of histamine in each dog; so, the cases that showed a drop in blood pressure of more than 10 mmHg were omitted (Fig. 3).

In this group, change of the oxygen tension by histamine administration remained within 5 percent and secretion of gastric juice showed no change as compared with that before injection (Fig. 4).

2. Perfusion group

a. Perfusion with low molecular weight dextran solution

Occlusion of the splenic artery was released one hour after the perfusion and histamine solution was injected intramuscularly (Fig. 5). The oxygen tension in the venous blood decreased 20 to 30 percent 30 to 40 minutes following the administration, and gastric secretion increased (Fig. 6).

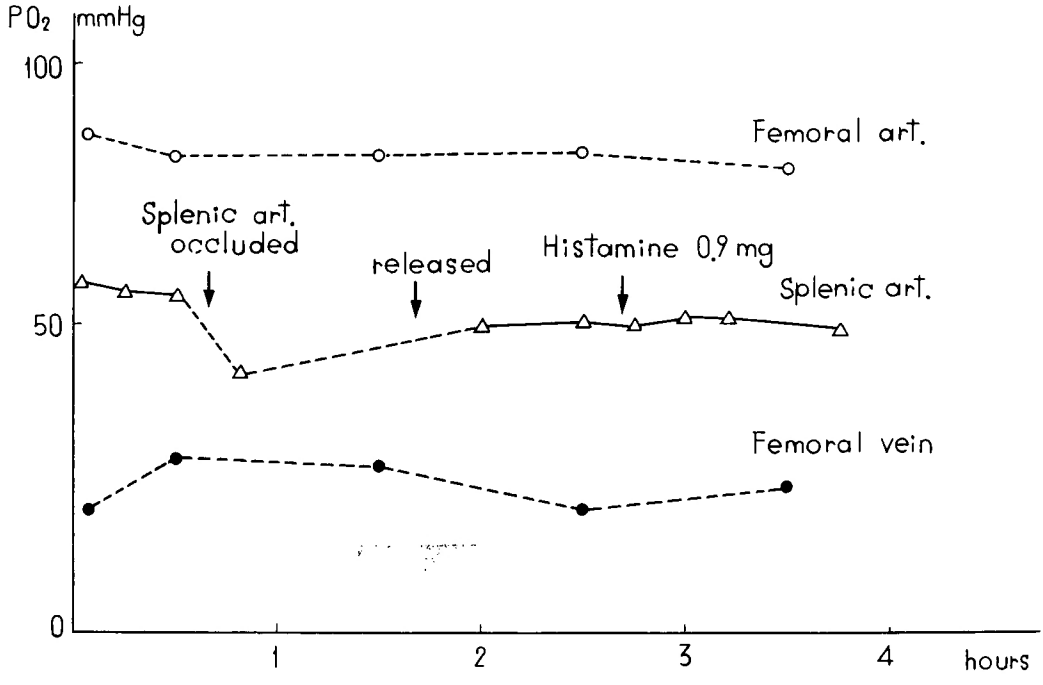

Fig. 3 Recordings of oxygen tension of the blood in a dog without perfusion of the graft. The oxygen tension of the venous blood did not decrease following histamine administration.

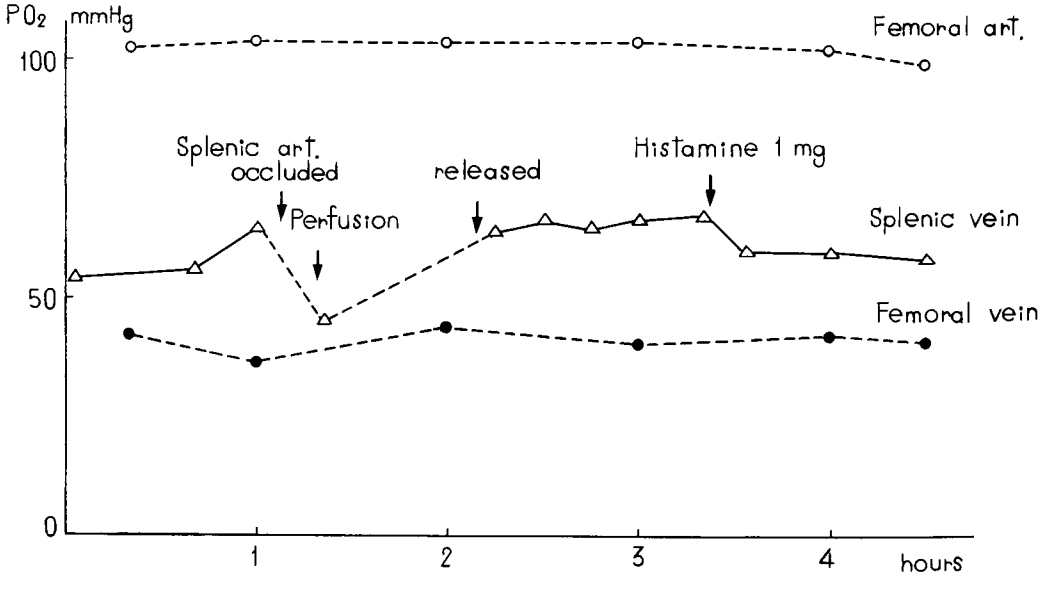

Fig. 5 Recordings of oxygen tension of the blood in a dog with perfusion of the graft. The oxygen tension of the splenic venous blood decreased by 20% following histamine administration.

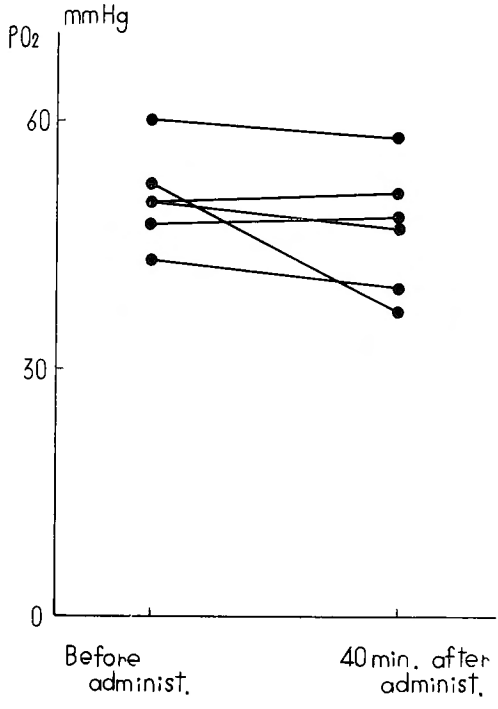

Fig. 4 Changes in the oxygen tension of the venous blood flowing out of the grafts in non-perfusion group.

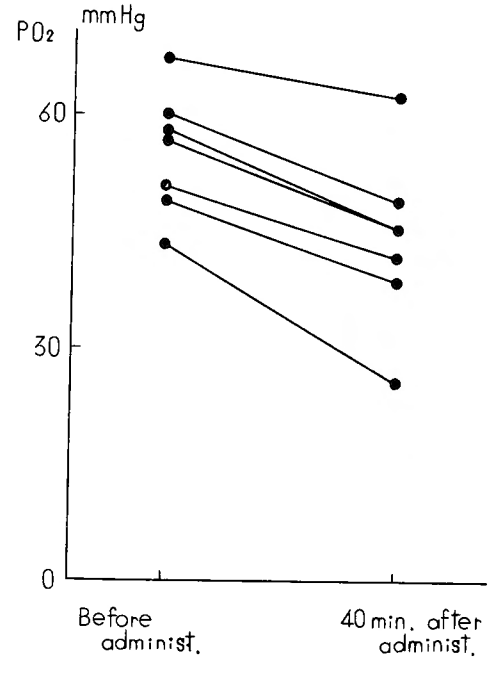

Fig. 6 Changes in the oxygen tension of the venous blood flowing out of the grafts in perfusion group.

b. Perfusion with physiological saline solution

Although only three cases were studied in this group, their results were identical with the dextran group.

It has been known that arteriovenous anastomoses, present chiefly in the submucosa of the stomach and intestines, are closed by histamine administration and arterial blood traverses thoroughly through the capillary bed of the mucosa. Furthermore, they are kept open by operative manipulation of the stomach or intestines, and arterial blood does not flow sufficiently through the capillary bed but shunts directly into the the veins through a-v anastomoses.

These experimental results show that perfusion of transplants keeps a-v anastomoses open, and arterial blood does not flow thoroughly through the mucosal capillary bed, so that undesirable influences upon the hemodynamics of transplants occur following transplantation.

The amount of outflow blood of transplants was directly measured in 6 dogs, but did not decrease remarkably in any cases by histamine administration.

II REPLACEMENT FOR THE CERVICAL ESOPHAGEAL DEFECT BY FREE TRANSPLANTATION OF A GASTRIC TUBE IN DOGS

1. Operative procedures

Gastric tubes were created by the same procedure described above. The splenic vessels

were isolated and divided.

In some dogs, transplants were perfused with heparin-low molecular weight dextran solution, and in other dogs they were left at room temperature without perfusion. The left external jugular vein and the left common carotid artery were isolated through an oblique incision at the anterior margin of the sternocleidomastoid muscle, about 15 cm in length, and divided into suitable lengths for subsequent vascular anastomoses with the splenic vessels. Arterial anastomosis was accomplished between the proximal cut end of the common carotid artery and the splenic artery supplying transplants by means of INOKUCHI's vessel suturing apparatus. Venous anastomosis was performed in the same fashion between the external jugular vein and the splenic vein.

These dogs were divided into two groups. In one group, transplants were placed in a subcutaneous pocket and an external fistula was created by bringing out the distal end through a stab wound. A segment, approximately 5 cm in length, of the cervical esophagus was resected in another group. Then, the revascularized gastric tube was interposed isoperistaltically between both cut ends of the esophagus and end-to-end anastomoses were completed[11].

All dogs were given subcutaneously 500 to 1,000 ml of 5 % glucose and RINGER's solution, and intramuscularly 1 g of chloramphenicol every day.

RESULTS

In none of 8 dogs were the grafts transplanted in subcutaneous space perfused. Six dogs survived and 2 died of shock during early postoperative period. In 9 dogs the cervical esophageal defective portions were replaced. Two of 4 dogs in the perfusion group and 3 of 5 dogs in the non-perfusion group survived for a long time (Table 1). Dog No. 12, the first case, was sacrificed on the 7th postoperative day on account of the anastomotic leakage, but its graft with patent vascular anastomoses was viable. Dog No. 16 had slight difficulty in swallowing, but necropsy showed no stenosis at the anastomotic regions (Fig. 7, 8). Dog No. 28 showed gradually increased dysphagia and died of emaciation 7 months after operation. Dog No. 21 had done well postoperatively, but died

Table 1 Reconstruction of the cervical esophagus with a free gastric tube in dogs

Dog No.	Body weight (kg)	Vessel anastomosis		Perfusion	Survival	Cause of death
		Artery (mm)	Vein (mm)			
12	14.5	1.5	3.5	(−)	7 days	Sacrificed
13	15.5	2	3.5	(−)	1 year	Sacrificed
16	20.0	2	4	(−)	1 year	Sacrificed
20	14.7	2	4	(−)	14 hours	Shock
21	20.5	1.5	4	(−)	1 month	Epidemic kennel infection
24	12.5	1.5	3	(+)	24 hours	Shock
26	16.5	2	3.5	(+)	2 days	Shock
28	16.5	2	4	(+)	6 months	Emaciation
29	23.0	3	4	(+)	8 months	Sacrificed

Perfusate : 6% D-Dextran (200 ml) added with heparin (30mg).
INOKUCHI's vessel suturing apparatus was used.

Fig. 7 Roentgenological findings of the esophagus 3 months after free transplantation show ready passage (Dog No. 16).

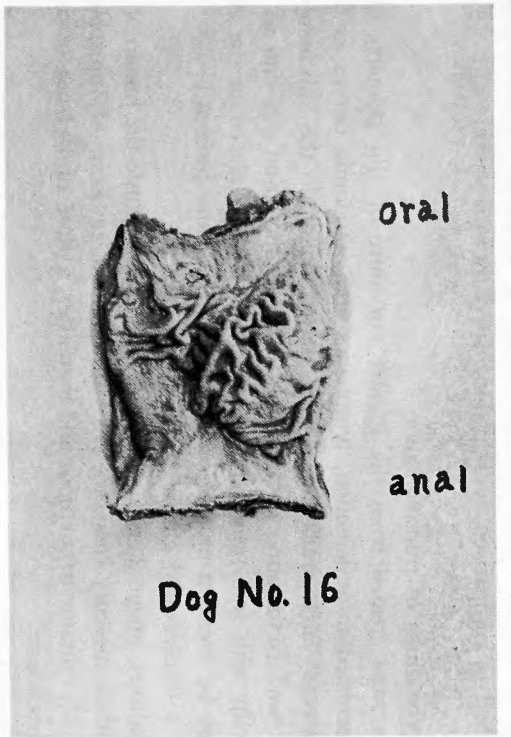

Fig. 8 Specimen of a gastric tube removed at necropsy 12 months after free transplantation (Dog No. 16). Strictures at the anastomotic region had not been developed and its mucosa showed the appearance of the normal stomach.

Fig. 9 An angiogram taken 8 months after free transplantation (Dog No. 29). The anastomosed artery and vein showed complete patencies.

of epidemic kennel infection.

There were no significant differences in results between these two groups. Although a better result was obtained in the non-perfusion group, it could not be attributed to perfusion. In the perfusion group, operative procedures became more troublesome, so that operation time was prolonged.

Venous anastomosis was performed easily by means of a vessel suturing apparatus. On the other hand, arterial anastomosis was difficult to perform in a few cases because of the small diameter of arteries supplying transplants, but succeeded in all cases (Fig. 9).

III THE INFLUENCES OF SEVERANCE OF THE EXOGENOUS AUTONOMIC NERVES AND LYMPHATIC VESSELS UPON THE FUNCTIONS OF A GASTRIC TUBE TRANSPLANTED BY MEANS OF VASCULAR ANASTOMOSES

In free transplantation, blood vessels are revascularized but exogenous nerves and lymphatics are not reconstructed. Therefore, influences of severance of these nerves and lymphatics were studied in comparison with pedunculated transplantation.

1. Methods

a. Operative procedures of transplantation

Gastric tubes were created from the greater curvature of the stomach in the same fashion. In pedunculated transplantation, lymphatics and autonomic nerves in the vascular pedicle were preserved and gastric tubes were transplanted into the subcutaneous portion of the abdominal wall by creating an external fistula at the distal cut end of the gastric tube. In the group with free transplantation, transplants were placed in the subcutaneous pocket at the neck by creating an external fistula in the same fashion.

b. Motility of a transplanted gastric tube

A gummy balloon, about 2 cm in diameter, was inserted into the lumen of transplants and connected with a mercury manometer. Intraluminal pressure of transplants was recorded for about 30 minutes to an hour and thereafter, a dose of 0.1 mg of vagostigmine was injected intravenously.

c. Local clearance of ^{32}P

The serosa was exposed through a small skin incision over transplants and 0.2 ml of radioactive orthophosphate solution was injected under the serosa.

Radioactivity ratio at the injected point was measured every 30 minutes for two hours by means of a GEIGER-MUELLER counter. The rate of decrease of radioactivity was calculated and its time of reduction by half was decided.

d. Histological examinations

Specimens of transplants taken at autopsy were stained with hematoxyline-eosin and KOELLE's thiocholine method for choline esterase activity was also used.

2. Results

a. Motility of transplants

In the pedunculated transplantation group, typical peristaltic movements were observed without activation for about 10 to 14 days following transplantation. The response of transplants to vagostigmine was most active and the intraluminal pressure curve showed high amplitude. However, three or more months after operation, movements of transplants

became atypical and their amplitude decreased (Fig. 10). In the free transplantation group, typical movements were not observed and their amplitudes were lower than the pedunculated

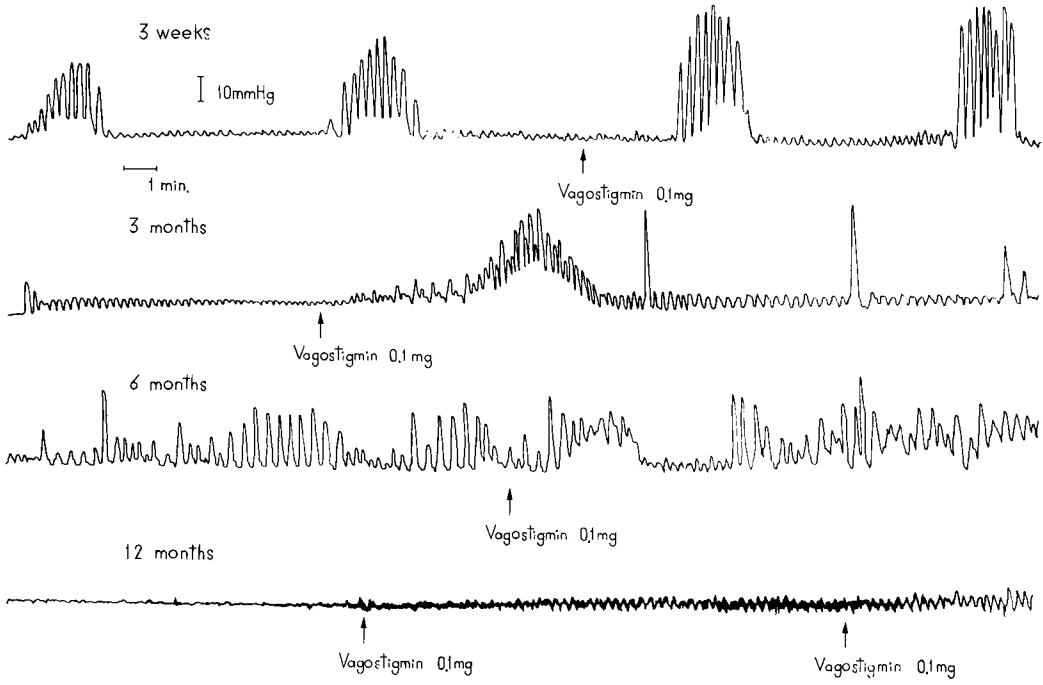

Fig. 10 Intraluminal pressure of pedunculated graft transplanted into subcutaneous portion of the abdominal wall.

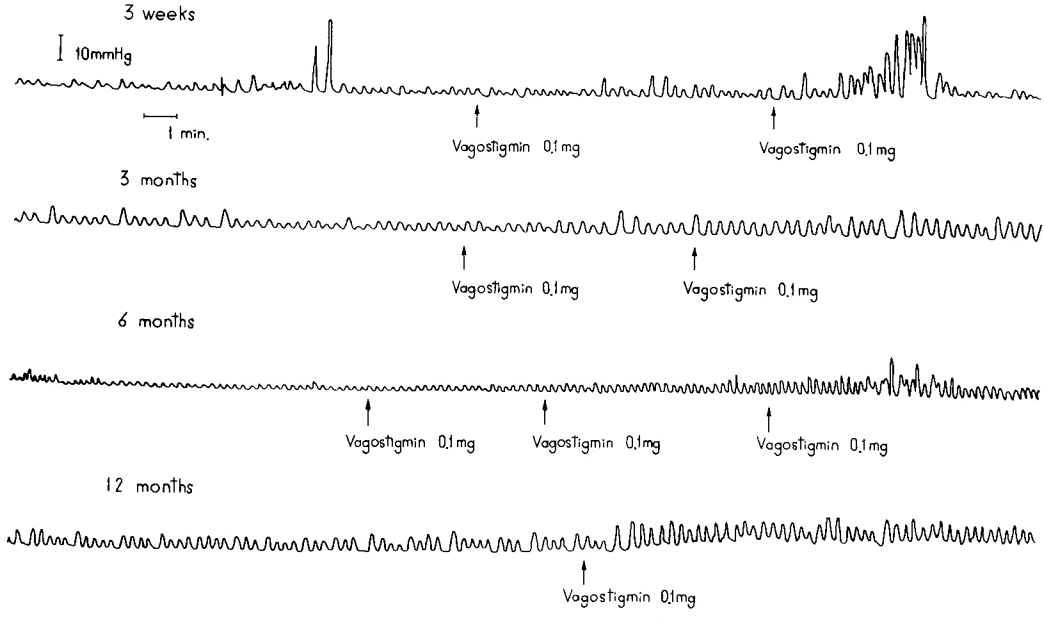

Fig. 11 Intraluminal pressure of free graft transplanted into subcutaneous pocket at the neck.

group at an early postoperative stage (Fig. 11). Nevertheless, no significant difference in curves was observed between these two groups one year after operation.

b. Local clearance of ^{32}P

Time of reduction by half of radioactivity was 36 minutes in the pedunculated group and 40 minutes in the free group, 3 weeks after operation. Three months postoperatively, it was 21 minutes in the former and 100 minutes in the latter. These showed prolon-

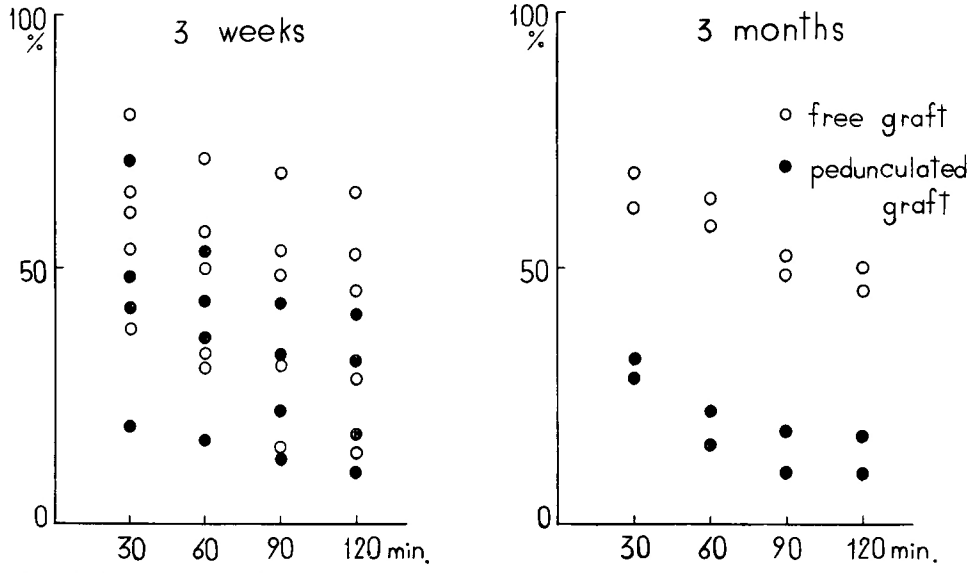

Fig. 12 Local clearance of ^{32}P injected into free and pedunculated transplants 3 weeks and 3 months postoperatively.

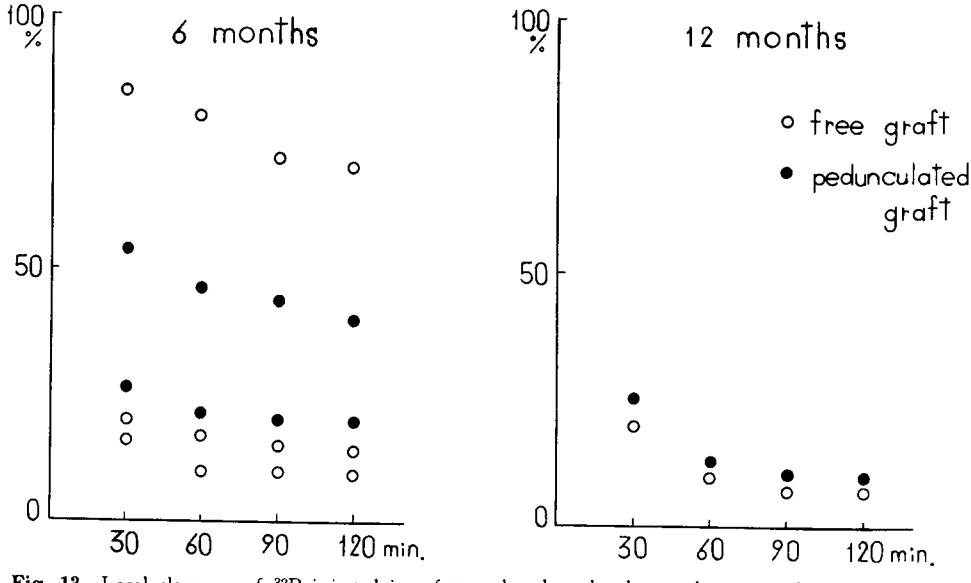

Fig. 13 Local clearance of ^{32}P injected into free and pedunculated transplants 6 and 12 months postoperatively.

gation of the local clearance in the free transplantation group at an early postoperative stage, but no significant difference was noted between these two groups one year after operation (Fig. 12, 13). These results show that the new lymphatic drainage from the free transplants should be completed from 3 months to one year postoperatively.

c. Histological findings

H. E.-staining

No remarkable change was revealed in both groups of subcutaneous transplantation, but a slight atrophy of the muscular layer was observed. Nerve cells of the AUERBACH's plexuses increased remarkably in their amount (Fig. 14). This change could be attributed to any factors other than false increase of the plexus due to the atrophy of the wall of transplants.

Activity of choline esterase

Although the activity increased slightly in comparison with normal tissue of the stomach, differences between free and pedunculated transplantation were scarcely demonstrated (Fig. 15).

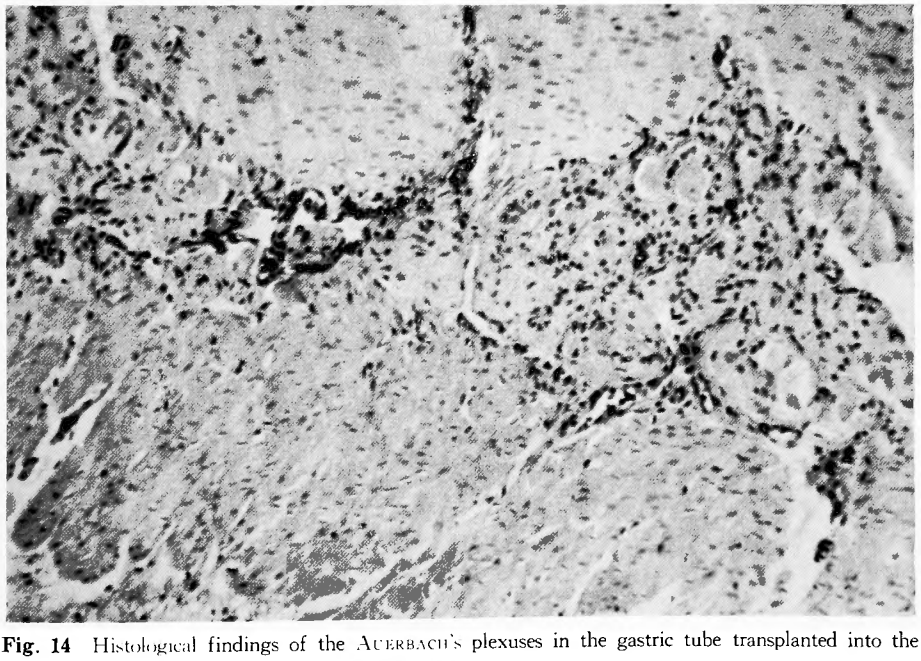

Fig. 14 Histological findings of the AUERBACH's plexuses in the gastric tube transplanted into the cervical subcutaneous portion (H. E.-staining).

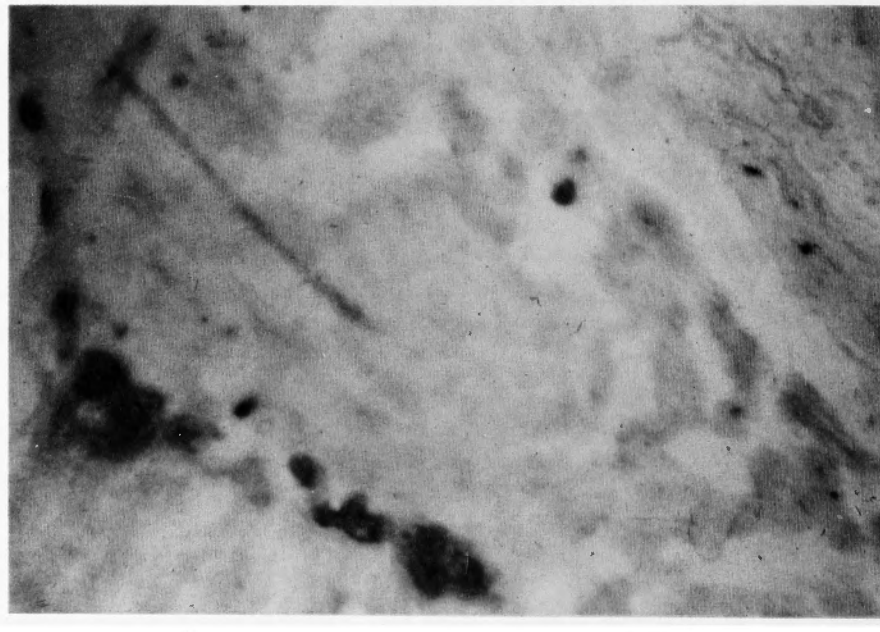

Fig. 15 Histochemical findings of choline esterase of the gastric tube transplanted into the cervical subcutaneous portion (KOELLE's thiocholine method).

IV CLINICAL EXPERIENCES IN THE CERVICAL ESOPHAGEAL RECONSTRUCTION BY FREE INTESTINAL TRANSPLANTATION IN OUR CLINIC

We operated on 6 patients up to 1967. They were comprised of 2 cervical esophageal carcinomas, 3 hypopharyngeal carcinomas and one cicatricial stenosis of the cervical esophagus (Table 2). In the first two cases sigmoid colon was transplanted, but in the remaining cases the esophageal defective sections were replaced by means of the terminal portion of the ileum. In the first case the graft was perfused with dextran, but in the others, transplants were only flushed by physiologic saline solution to which heparin was added. All of the venous anastomoses were performed by means of INOKUCHI's vessel suturing apparatus and arterial anastomoses, except one, were carried out by NAKAYAMA's apparatus. The external carotid artery was selected as the recipient artery in 4 cases from the point of its larger caliber, but no trouble was encountered during operation. Anticoagulant was not administered generally during or after operation, but low molecular weight dextran solution was injected intravenously in a dripping fashion before and after vascular anastomoses in a few cases[7)23)].

Two patients survived for a long time. One of them was a 22-year-old youth suffering from cicatricial stenosis and reconstructed with a segment of the ileum after en bloc resection of the stenosed portion of the esophagus together with the remaining larynx. The vascular anastomoses were performed very easily by using INOKUCHI's blood vessel suturing apparatus because of no arteriosclerotic change. He has been doing very well since the operation (Fig. 16).

Table 2 Clinical cases of esophageal reconstruction with a free intestinal segment after cervical esophagectomy

Case	Age	Sex	Disease	Transplant (Perfusion)	Vessel anastomosis		Result
					Artery (mm)	Vein (mm)	
1	68	M	Cerv. esoph. carcinoma	Sigmoid colon (+)	A. fac. -A. mes. inf. INOKUCHI's 1.5	V. fac. -V. mes. inf. INOKUCHI's 2	Failed in vascular reconstruction
2	64	F	Cerv. esoph. carcinoma	Sigmoid colon (−)	A. subscap. -A. mes. inf. INOKUCHI's 3	V. jug. ext. -V. mes. inf. INOKUCHI's 4	Died after 4 months
3	73	M	Hypopharyng. carcinoma	Ileum (−)	A. carot. ext. -A. intest. NAKAYAMA's 4	V. jug. int. -V. intest. INOKUCHI's 4	Died of cardiac arrest 30 min. after transplant.
4	22	M	Cicatricial stenosis	Ileum (−)	A. carot. ext. -A. intest. INOKUCHI's 3	V. jug. int. -V. intest. INOKUCHI's 4	Alive, 20 months postoperatively
5	53	M	Hypopharyng. and cerv. esoph. carcinoma	Ileum (−)	A. carot. ext. -A. intest. NAKAYAMA's 4	V. jug. int. -V. intest. INOKUCHI's 4	Died of bleeding at the site of vessel anastomosis after 36 days
6	66	M	Hypopharyng. and cerv. esoph. carcinoma	Ileum (−)	A. carot. ext. -A. intest. NAKAYAMA's 4	V. jug. int. -V. intest. INOKUCHI's 4	Ileoesophageal anastomotic breakdown

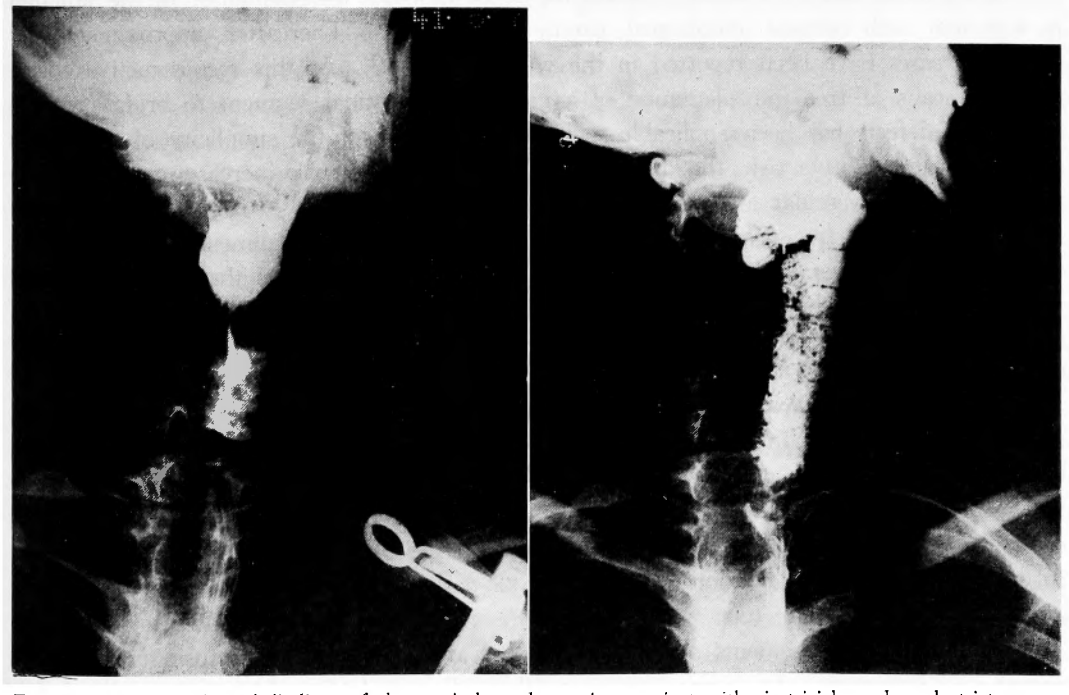

Fig. 16 Roentgenological findings of the cervical esophagus in a patient with cicatricial esophageal stricture. Left : Preoperative. Right : Six months after free transplantation.

DISCUSSION

The first case of reconstructive operation of the cervical esophageal defect by resecting a carcinoma from the cervical portion of the esophagus and successfully suturing both ends of the defect was performed by CZERNY in 1877. HACKER and BUECHNER devised a method for the reconstruction by using a skin graft. ROUX, BECK and KIRSCHNER[18] reconstructed respectively by pedunculated transplantation of the stomach or intestine. Especially, the esophageal reconstruction with a pedunculated gastric tube[21] originally devised by KIRSCHNER has been most frequently utilized since NAKAYAMA[25] promoted it. On the other hand, artificial esophagus has been used with the progress of high molecular chemistry, but has not given satisfactory results experimentally and clinically.

However, with the advent of small vessel anastomosing techniques, reconstructive operations for cervical and upper thoracic esophageal defects by means of free transplantation of a gastric or intestinal segment have been frequently applied. Although suture or non-suture methods using small cylinder prostheses or rings have been devised, anastomoses of blood vessels smaller than 3 mm in external diameter are just as difficult to perform as before.

Recently, JACOBSON[15] reported excellent results with a microvascular surgical technique, but this method requires considerable experience and dexterity. In 1950, GUDOV developed circumferential stapling instrument. INOKUCHI[12] in 1957 and NAKAYAMA[26] in 1961 developed independently small vessel suturing apparatuses, and therefore, blood vessels as small as 2 mm in external diameter have been successfully anastomosed.

SEIDENBERG and co-workers[36] succeeded in the first free transplantation of the jejunum in a patient with cervical esophageal carcinoma in 1957. Thereafter, approximately 40 successful cases have been reported in the world[5)9)24)28)31]. As this reconstructive operation by means of free transplantation of a gastric or intestinal segment to bridge cervical esophageal defects has been applicable more safely because of the simplicity of techniques and no great operative risk, the number of successful cases may increase greatly due to generalization of vascular anastomosis.

Selection of a free transplant from among various parts of the alimentary tract depends on the choice of operators, but many factors, such as the diameter of the nutritional blood vessels, difficulty of the operative manipulation in removing it and reconstructing continuity, the size of its lumen, resistance of the transplant to the disturbance of blood circulation, and bacteriology of its contents, should be considered.

According to the experimental studies on the amount of cathepsin in various parts of the digestive tract by MATSUO[22] in our clinic and on the amount of their tissue respiration by FURUKAWA[8] in our clinic, sigmoid colon is the most suitable for free transplantation from the point of the resistance to ischemia during and after operation, and ascending colon, stomach, jejunum and ileum are preferable in the order mentioned. In 41 successful cases in free transplantation up to date, 22 colonic, 15 small intestinal, 3 ileocaecal segments and one gastric tube were utilized.

Among the managements of a free transplant after its removal, perfusion is the most urgent and important. In many experimental studies and clinical operations, perfusion with physiologic saline or dextran solution was carried out. NAKAYAMA et al.[27] reported

that it is better to leave transplants at room temperature for one or two hours and denied the need of perfusion. INOKUCHI et al.[13)14)] pointed out that perfusion was unnecessary from the viewpoint of the peripheral vascular resistance of transplants. It has been known that arteriovenous anastomoses in the wall of the alimentary tracts[2)3)16)17)38)] open when the gastrointestinal canal is exposed to the atmosphere by laparotomy or manipulated, and therefore, arterial blood bypasses directly into veins without traversing through the capillary bed of the mucosa. PETERS and WOMACK[32)] demonstrated that the oxygen saturation of the splenic venous blood rose to the level of the arterial blood by the administration of adrenalin, and secretion of the gastric juice was also inhibited remarkably, but on the other hand, the secretion increased with histamine administration and the oxygen saturation did not change or fell slightly. These show that although a-v anastomoses dilate with adrenalin, they close with histamine, and the metabolic work of the mucosa becomes greater on account of the increased blood flow through the mucosal capillary.

The author studied on the necessity of perfusion of transplants and demonstrated that the oxygen content of the venous blood flowing out of them fell 20 to 30 percent when histamine was administered following perfusion with heparin-low molecular weight dextran or physiologic saline solution. Moreover, blood pressure of dogs did not drop except for a few cases in shock and determination by the direct method did not show any decrease of the amount of venous blood flow out of transplants. But, in the cases without perfusion the change in oxygen content did not fall below 5 percent following histamine administration.

FURUKAWA in our clinic demonstrated that tissue respiration of a segment of sigmoid colon decreased 31.4 percent after perfusion. This probably resulted from the fact that the lyo-enzyme types of respiratory enzymes and low molecular weight coenzymes of respiratory enzymes were dissolved and washed out by perfusion. Decrease of the oxygen saturation in the venous blood flowing out of transplants after histamine administration can not be attributed only to the loss of these enzymes. The author understood that this decrease showed the a-v anastomoses were opened by operative procedures and remained patent following perfusion, but closed with histamine administration, and consequently, arterial blood traversed thoroughly through the capillary bed of the mucosa and the oxygen consumption of transplants decreased. Although perfusion of transplants with low molecular weight dextran solution[10)] has the advantage of preventing sludging after the release of blood flow occlusion, it also has a disadvantage of dissolving away respiratory enzymes, and moreover, arterial blood shunts away directly into veins because of the persistent patency of a-v anastomoses. Therefore, perfusion of transplants is quite unnecessary when they are revascularized immediately after their removal[39)]. In replacement for the cervical esophageal defect by means of a free gastric tube in dogs, no remarkable difference was observed in the results of transplantation between both groups with or without perfusion of the transplants, but it made operative procedures more laborious and time consuming.

Some difficulties were encountered in clinical cases with arterial anastomosis because of arteriosclerotic changes in the arterial wall except for the cases with cicatricial stenosis in young people. From our experiences in the vascular anastomosis, the suture method is more reliable than instrumental anastomosis in the cases with advanced arteriosclerotic changes such as cancer patients.

The functions of an autotransplanted gastric or intestinal segment at a remote date are influenced by temporary ischemia during transplantation, and by the severance of lymphatic vessels and exogenous autonomic nerves. LILLEHEI et al.[19] observed the recanalization of lymphatics during 2 or 3 weeks postoperatively in the case of the isotopic retransplantation after the severance of the vascular pedicle or lymphatics alone. However, in heterotopic transplantation such as in the subcutaneous tissue at the neck, regeneration will be retarded because there is no stump of lymphatics to recanalize in the central side. Judging from the author's results on local clearance of ^{32}P injected into free transplants, lymphatic circulation began to restore within 3 months and became normal one year postoperatively.

Concerning the influences of ischemia during transplantation and denervation upon transplants, BALLINGER et al.[1] reported that weight loss, severe diarrhea, decreased absorption of fat, almost complete loss of the mucosa and shortened villi of the regenerated mucosa were observed in isotopic autotransplantation of the entire intestine distal to the duodenum in dogs, but these findings returned to normal for 4 to 6 months following transplantation.

In the author's studies, no specific findings were observed by microscopic examinations[6], but nerve cells of the AUERBACH's plexuses in both groups increased in their amount and were stained more clearly 3 or more months after transplantation, although remarkable changes of degeneration in these plexuses were not observed. OKAMOTO et al.[30] investigated on the changes of intramural nervous elements of the hypertrophic bowel proximal to the stenosed segment and observed the increase of nerve cells in AUERBACH's plexus in number. They interpreted this finding as the maturity of unripe cells owing to hyperfunction of the proximal portion of the stenosed segment. Similarly, the false increase of those plexuses in free transplants seemed to be compensatory hypertrophy on account of denervation.

It is generally recognized that the intestinal segment with severed exogenous autonomic nerves retains its own proper motility and presents no abnormal patterns in its active potential. From the author's observations, in the pedunculated transplantation group more typical peristaltic movements were observed than in the free transplantation group at an early postoperative stage, but both groups responded actively to parasympathicomimetic drugs. However, their motilities became gradually atypical and their amplitude lower. One year after operation, differences of motilities were scarcely observed between these two groups.

Considered from its morphology and motility, a free gastric tube transplanted by means of vascular anastomoses was demonstrated to function well as a conduit at a remote date following the operation.

SUMMARY

In the replacement for cervical and upper thoracic esophageal defects by free transplantation of a gastric or intestinal segment in dogs, the necessity of perfusion and the influences of severance of exogenous nerves and lymphatics upon its functions were investigated. Moreover, reconstructive operations were carried out on experimental dogs and clinical patients and following results were obtained:

1) Perfusion with low molecular weight dextran solution helped to maintain the

patency of arteriovenous anastomoses in free transplants after revascularization and, therefore, arterial blood did not traverse thoroughly through the capillaries of the mucosa. Consequently, the necessity of perfusion was denied and its harmful effect was pointed out, when the transplants are revascularized immediately after their removal.

2) The functions of free transplants, such as local clearance of ^{32}P and motility, became almost the same as pedunculated transplants three or more months postoperatively.

3) In the replacement of the cervical portion of the esophagus with a free gastric tube in dogs, no remarkable difference was observed in the results of transplantation between both groups with or without perfusion of the transplants and comparatively good results were obtained in both groups.

4) We obtained a long-term survival of a young male patient who had been suffering from cicatricial stenosis of the cervical esophagus since his childhood, and this was reconstructed by means of free transplantation of a segment of the ileum.

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和文抄録

胃腸管完全遊離移植による高位食道欠損補塡に関する研究

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頸部または上胸部食道の悪性腫瘍や良性狭窄に対する外科的治療としての食道再建術は，胃腸管の有茎移植，あるいは完全遊離移植によつて現在ほぼ目的が達成されている．しかしながらこれらの手術，とくに胃腸管完全遊離移植についてはなお未解決の点が少なくなく，たとえば完全遊離移植片採取後の処理，ことにそれを灌流して脱血する操作が必要であるか否かについてはなお意見の一致をみていない現状である．また完全遊離移植の際には血管は再建されるか，神経およびリンパ管は切断されたままであり，このことが移植片の形態および機能におよぼす影響，さらには移植片の採取部位などについても検討の必要がある．

そこで，著者は犬を用いてその大彎側より胃管を作製し，

1) ヘパリン加低分子デキストランあるいは生理的食塩水で移植片を灌流し，その還流静脈血の酸素分圧を生理学用ガス分析計で測定した．

2) 実験犬で遊離胃管による頸部食道再建を実際に行ない，灌流が手術成績におよぼす影響を検討した．

3) 外来自律神経およびリンパ管の切断が遊離胃管の機能におよぼす影響について，有茎胃管群を対照として，^{32}P 局所クリアランス，運動機能，病理組織学的所見を比較検討した．

また，

4) 教室における完全遊離腸管による頸部食道再建臨床例の経験を述べた．

これらの実験および手術の結果から，

1) ヒスタミンを投与すると，移植片の還流静脈血の酸素分圧は灌流群では20ないし30%の低下を示したが，非灌流群では約5%の変化をみたにすぎなかつた．このことは灌流が手術操作などによつて開存しているA-V anastomosisをその状態に継続せしめることを示している．

2) 実験犬における頸部食道再建では，灌流の影響はみられず，血行再建は器械吻合で確実に成功し，比較的好成績が得られた．

3) ^{32}P 局所クリアランスは移植後3ヵ月までは遊離移植群で高い値を示したが，6ヵ月以上を経過すると有茎移植群との間に差はみられなかつた．

4) 移植片の内圧曲線では，移植後3週では有茎移植群に定型的な蠕動運動を認めたが，ワゴスチグミンには両群共によく反応した．3ヵ月を経過すると両群の間に差はなくなつた．

5) 臨床例において完全遊離腸管による頸部食道再建6例を経験し，2例に長期生存を得た．とくにそのうちの1例は若年者の頸部食道狭窄例で，血行再建は器械吻合で全く容易であり，術後の結果も良好であつた．

すなわち，

1) 移植片採取後短時間で血行再建が可能な自家移植では灌流はむしろ有害無益である．

2) 完全遊離移植胃管は長期を経過すれば，その機能において有茎移植胃管と同様の態度をとり，代用食道としての機能を十分に果たすことができる．

3) 犬における完全遊離移植では血行再建は器械吻合器を用うると全く容易であつたが，動脈硬化性変化の進んだ臨床例では動脈吻合の施行にはなお問題があり，手縫い法などを考慮すべきである．